Update on the Environmental Impact Analysis and Contract for the 33% Renewable Electricity Standard (RES)

ARB staff is performing the following tasks for the environmental impact analysis for the 33% RES:

- Assessing the impacts of all criteria pollutant emissions associated with renewable resources included in the plausible scenarios:
  - wind
  - solar thermal
  - solar PV
  - geothermal
  - solid-fuel biomass
  - landfill/digester gas
  - small hydro
- Comparing the criteria pollutant emissions from the renewable resources to the 2020 average grid emissions data;
- Determining the environmental benefits and quantifying those, where appropriate;
- Evaluating other environmental impacts such as land, water, biological, cultural and visual impacts;
- Assessing the impacts to environmental justice and low-income communities;
- Working with the Department of General Services (DGS) on the Request for Qualifications (RFQ) for a consultant contract (see Attachment 1 for more details); and
- Developing summaries of these impacts (see Attachment 2 for the **draft** analysis of each renewable resource noted above). Reviewing available reports from the California Energy Commission, California Public Utilities Commission, and California Independent System Operator, as well as from federal, other state and local agencies.

ATTACHMENT 1

Summary of Environmental Impact Analysis Contract for the 33% Renewable Electricity Standard

Contract Purpose

The purpose of this solicitation is to retain a professional firm with knowledge and experience in renewable energy production and transmission, facility siting, economic and market-based operations and energy systems, and preparation of environmental documents. This request is to solicit a statement of qualifications from experienced and qualified firms to provide a project work plan, timeline and to prepare the environmental documentation for the Air Resources Board's (ARB) proposed Renewable Electricity Standard (RES) regulation.

Scope of Work

The contractor will conduct a California Environmental Quality Act (CEQA) equivalent analysis of California's renewable electricity regulation. The environmental impact analysis will address the impacts of plausible scenarios, provided by the ARB, for complying with the proposed renewable electricity standard (RES) regulation. The contractor will evaluate new renewable generation facilities and associated fossil-fuel powered generation and upgraded and new transmission and distribution lines. The contractor will analyze the potential air, land use, water quality, biological, cultural and visual impacts of each plausible compliance scenario and identify mitigation measures to reduce these impacts.

Alternatives to the proposed project will be a part of the analysis, as CEQA requires an environmental impact report to describe and evaluate the comparative merits of a range of reasonable alternatives to a proposed project.

The final product of this contract will identify and evaluate the potential environmental impacts of increasing the availability and use of renewable electricity generation. The analysis will also include actions to mitigate these impacts.

Status

ARB has submitted the pertinent documents to DGS to prepare the RFQ. DGS is working diligently to expedite the process. ARB hopes to interview potential bidders within the next few weeks and select a contractor by the end of February 2010.

ATTACHMENT 2

Draft Environmental Analysis of Each Renewable Resource

Potential Environmental Impacts From Wind Power Generation

BACKGROUND

- Wind farms generated 6,802 gigawatt-hours of electricity - about 2.3 percent of the state's gross system power in 2007.
- 17 projects are expected to begin construction in 2010.
- California has three major wind farm regions that include more than 13,000 wind turbines: Altamont Pass, Tehachapi, and San Gorgonio.
- Wind energy has zero air emissions; however, wind energy affects biological resources and visual resources.

ENVIRONMENTAL IMPACTS

Air Quality

- The only air emissions associated with wind energy are the emissions from the back-up energy source required during intermittent periods of operation.
- Table 1 compares criteria pollutant emissions from wind power generation to the average generation emissions from the California electricity grid.

Table 1 Criteria Pollutant Emissions from Wind Power (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Operating Emissions[1]	0	0	0	0	0	0
Avoided Emissions[2]	0.009	0.067	0.006	0.136	0.039	0.039

Sources: ARB and CEC
1. Backup power emissions and Transportation/Maintenance emissions are excluded
2. Avoided Emissions = 2020 Average Grid Emissions - Operating Emissions

Aesthetics

- Wind turbines can be highly visible because of their height and locations (e.g., ridgelines and open plains). The visual impacts of wind energy projects may well be a factor in gauging site acceptability.
- A solid red light glowing on a wind turbine, which warns low-flying aircraft of the structure, can be a concern to nearby residents.

Biological Resources

- Danger to birds and bats has been a concern in some locations.
- CEC has developed guidelines to minimize risk.

Land Use and Planning

- Wind energy requires land to be disturbed only one time.
- Two studies were made to determine if wind farms could have a negative affect on nearby home values; both studies found little evidence to support the claim that home values are negatively affected by the presence of wind power generation facilities.

Transportation/Traffic

- Roadways need to be provided for facilities that will use traditional vehicles to construct the wind farm and to make accessible for maintenance staff.
- Planned closure of small streets needs to be made in the transportation of large wind turbine components.

Water Quality

- Wind farms near housing developments may require a new water line for maintenance personnel.
- Maintenance staff in remote areas may need a portable septic system.

Other Impacts

- Transmission lines must be built to access any future wind farm. This poses a challenge to those wind farms that are sited 100s of miles away from standard transmission lines.
- Backup power for wind generation may be an issue. Storage technologies are currently in the research and development stage.

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

California Energy Commission, *2009 Integrated Energy Policy Report*

California Energy Commission, Wind Energy in California website: http://www.energy.ca.gov/wind/index.html

Shasta County Department of Resource Management, *Draft Environmental Impact Report for the Hatchet Ridge Wind Project*, December 2007

United States Department of Energy, *20% Wind Energy by 2030; Increasing Wind Energy's Contribution to U.S. Electricity Supply*, July 2008, Chapter 5

Potential Environmental Impacts From Solar Thermal Electricity Generation

BACKGROUND

- 13 plants operating in the U.S., total capacity of 409 MW
- 13 projects to begin construction in 2010, total capacity of 4,600 MW
- Most projects are planned for desert areas in Southern California, specifically in San Bernardino, Riverside, Kern and Imperial counties.

ENVIRONMENTAL IMPACTS

Air Quality

- Criteria pollutants are emitted from natural gas boilers used for morning start-up and for operation during cloud cover.
- Tables 1 and 2 compare criteria pollutant emissions from a 250 MW parabolic trough plant and a 400 MW power tower plant to the average generation emissions from the California electricity grid.

Table 1 Criteria Pollutant Emissions from a 250 MW Parabolic Trough Solar Thermal Plant (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Operating Emissions	0.007	0.004	0	0.003	0.014	0.006
Avoided Emissions[1]	0.002	0.063	0.006	0.133	0.025	0.033

Source: CEC FSA (2009), Beacon Solar Energy Project
1. Avoided emissions = 2020 Average Grid Emissions – Operating Emissions

Table 2 Criteria Pollutant Emissions from a 400 MW Power Tower Solar Thermal Plant (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Operating Emissions	0.004	0.013	0.002	0.015	0.019	0.008
Avoided Emissions	0.005	0.054	0.004	0.121	0.020	0.031

Source: CEC FSA (2009), Ivanpah Solar Electric Generating System
1. Avoided Emissions = 2020 Average Grid Emissions – Operating Emissions

Aesthetics

- Substantial visual impacts that can be difficult to mitigate:
  - general visual impacts to scenic desert landscapes;
  - tall power towers impact visual resources on flat landscapes; and
  - mirror glare and potential interference with aircraft operations.

Biological Resources

- Require large, flat land areas.
- Grading and land alterations can affect broad expanses of relatively undisturbed desert habitat for local and migratory species.
- New avian perching opportunities could affect both bird & prey populations.

Special-status **wildlife** species in Southern California desert areas where solar thermal plants are likely to be located:

- desert tortoise
- Mohave ground squirrel
- burrowing owl
- California horned lark
- golden eagle
- American badger
- blunt nose lizard

Special-status **plant** species in Southern California desert areas where solar thermal plants are likely to be located:

- Mojave milkweed
- desert pincushion
- nine-awned pappus grass
- Parish's club-cholla
- Rusby's desertmallow

Land Use and Planning

- Solar thermal plants require very large land areas (5-10 acres per MW; 60-120 MW per square mile).

Water Quality

- Most plants use conventional steam turbines to generate electricity, which commonly consume water for cooling.
- All plants currently in operation use wet cooling, where heat is dissipated by water evaporation in a cooling tower.
- In arid settings, the increased water demand could strain water resources. Solar thermal plants generally have the following water requirements:
  - 500-800 gal/MWh of water for wet-cooling (same as coal or nuclear); and
  - 20-40 gal/MWh of water for mirror washing.
- Dry cooling, where heat is rejected using fans and ambient air, can reduce water consumption at solar thermal plants by over 90%.

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

California Energy Commission, Final Staff Assessment, (2009). Beacon Solar Energy Project. *Application for Certification (08-AFC-2),* Kern County

California Energy Commission, Final Staff Assessment, (2009). Ivanpah Solar Electric Generating System. *Application for Certification (07-AFC-5),* San Bernardino County

California Energy Commission, Large Solar Energy Projects website: http://www.energy.ca.gov/siting/solar/index.html

Potential Environmental Impacts From Solar Photovoltaic (PV) Electricity Generation

BACKGROUND

- No utility scale plants in California (CA)
- 10 projects to begin construction soon, total capacity of 1,800 MW
- Projects are planned in Fresno, San Benito, San Luis Obispo, Kern, Los Angeles, San Bernardino, Riverside and Imperial counties.

ENVIRONMENTAL IMPACTS

Air Quality

- Once constructed, utility scale PV facilities require very little maintenance or resources to operate.
- Table 1 compares criteria pollutant emissions from a solar PV plant to the average generation emissions from the California electricity grid.
- Vehicles emit small amounts of criteria air pollutants during solar panel washing.

Table 1 Criteria Pollutant Emissions from a Solar PV Plant (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Operating Emissions	0	0	0	0	0	0
Avoided Emissions[1]	0.009	0.067	0.006	0.136	0.039	0.039

Sources: ARB and CEC
1. Avoided Emissions = 2020 Average Grid Emissions – Operating Emissions

Aesthetics

- Utility scale PV facilities can have general visual impacts to scenic landscapes that can be difficult to mitigate.

Biological Resources

- The use of large land areas by utility scale PV facilities can affect the habitats of local and migratory species.
- New avian perching opportunities could affect both bird & prey populations.

Examples of special-status **wildlife** species in Southern California desert areas where PV plants are likely to be located:

- Desert tortoise
- Mohave ground squirrel
- Burrowing owl
- California horned lark
- Golden eagle
- American badger
- Blunt–nosed leopard lizard
- Banded gila monster
- Nelson's bighorn sheep

Examples of special-status **plant** species in Southern California desert areas where PV plants are likely to be located:

- Small-flowered androstephium
- Mojave milkweed
- Desert pincushion
- Nine-awned pappus grass
- Parish's club-cholla
- Rusby's desert-mallow

Land Use and Planning

- PV facilities require very large land areas (about 10 acres per MW).

Water Quality

- 20-40 gal/MWh of water for solar panel washing
- Impacts to desert washes and downstream resources

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

California Air Resources Board, *CEIDARS Database*

California Energy Commission, *Energy Almanac*

California Energy Commission, Large Solar Energy Projects website: http://www.energy.ca.gov/siting/solar/index.html

Potential Environmental Impacts From Geothermal Power Generation

BACKGROUND

- California has the highest geothermal generating capacity in the U.S.
- 43 existing power plants, total capacity is 1,800 MW.
- Contributed about 13,000 GWh or 4% of total generation in 2008, excluding imports.
- The largest concentration of geothermal generation is in Lake and Sonoma counties.
- Several projects have been proposed in Imperial county, including a 159 MW capacity in Salton Sea and numerous facilities smaller than 50 MW capacity.

ENVIRONMENTAL IMPACTS

Air Quality

- Geothermal power plants have negligible air emissions, except for SOx emissions associated with the flash-steam technology (negligible for dry-steam technology).
- Table 1 compares criteria pollutant emissions from geothermal power generation to the average generation emissions from the California electricity grid.

Table 1 Criteria Pollutant Emissions from Geothermal Power Generation (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Operating Emissions[1]	0.001	0.002	0.015	0.004	0	0
Change in Emissions[2]	0.008	0.065	-0.009	0.132	0.039	0.039

Sources: ARB and AECOM
1. Flash-steam technology
2. Change in Emissions = 2020 Average Grid Emissions – Operating Emissions

Geology and Soils

- Although induced seismicity and landslides are not a common occurrence in hydrothermal operations, there has been active research to determine if well drilling, well workover, and fluid injection may increase these phenomena.

Land Use and Planning

- A geothermal power plant's footprint depends on its capacity and hydrothermal quality.
- Table 2 compares land use requirements for a specific hydrothermal technology to other power plants.

Table 2 Land Use Requirements for Various Power Plants

Power Plant	Land Use (m^2/MW)	Land Use (m^2/GWh)
110 MW geothermal flash plant (excluding wells)	1,260	160
20 MW geothermal binary plant (excluding wells)	1,415	170
49 MW geothermal FCRC plant[1] (excluding wells)	2,290	290
56 MW geothermal flash plant (including wells[2], pipes, etc.)	7,460	900
47 MW (avg) solar thermal plant (Mojave Desert, CA)	28,000	3,200
10 MW (avg) solar PV plant[3] (Southwestern U.S.)	66,000	7,500

Source: MIT, *Future of Geothermal Energy,* 2006

1. Typical Flash-Crystallizer/Reactor-Clarifier plant at Salton Sea, CA.
2. Wells are directionally drilled from a few well pads.
3. New land would not be needed if rooftop panels were deployed in an urban setting.

Noise

- Noise levels during normal operation are in the range of 70-85 decibels at a distance of 0.5 miles, which is comparable to the noise levels adjacent to a major freeway.
- Silencers and mufflers can be used to reduce operation noise.

Water Quality

- Well drilling, stimulation, and production result in a liquid stream that contains dissolved minerals, such as boron and arsenic; these minerals could potentially contaminate surface or ground water if they are not handled properly.
- Water supply is essential in multiple stages of geothermal projects:
  - development (well drilling and well workover)
  - operation (underground heat exchanger)
  - wet-cooling process (working fluid condensation)
- Dry-cooling process can reduce water consumption.
- Fluids extraction from hydrothermal reservoir could affect ground water table, surrounding hot springs, and land subsidence.

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

AECOM, *Amended Salton Sea Unit 6 Project*, 2009

California Air Resources Board, *CEIDARS Database*

California Energy Commission, *Energy Almanac*

California Energy Commission, Final Staff Assessment (Part 1), *Salton Sea Geothermal Unit #6 Power Project*, 2003

California Energy Commission, Final Staff Assessment (Part 2), *Salton Sea Geothermal Unit #6 Power Project*, 2003

California Energy Commission, Final Staff Assessment (Addendum), *Salton Sea Geothermal Unit #6 Power Project*, 2003

Massachusetts Institute of Technology, *The Future of Geothermal Energy,* 2006

Potential Environmental Impacts From Solid-Fuel Biomass Power Generation

BACKGROUND

- In 2008, solid-fuel biomass generation represented about 1.5% of the total system power (in-state and imports) or 15% of the total renewable generation (in-state and imports)[1].
- In 2008, solid-fuel biomass generation contributed more than 4,500 GWh.
- There are 31 solid-fuel biomass combustion facilities operating in California with a total capacity of 715 MW[2].
- Executive Order S-06-06 sets a 20 percent target for biomass[3] electricity generation within the established state goals for renewable generation for 2010 and 2020.
- Power plants, mostly combustion technology, are usually located within 15-50 miles of feedstock sources.
- Feedstock types: forest thinning 46%, urban wood 31%, and agriculture waste 23%.
- One million bone-dry tons biomass feedstock generate about 1,200 GWh.

ENVIRONMENTAL IMPACTS

Air Quality

- Table 1 compares the average criteria pollutant emissions from solid-fuel biomass plants to the average generation emissions from the California electricity grid.
- The operating emissions do not take into account offset emissions that would have resulted from uncontrolled burn of biomass feedstocks.
- Table 2 shows diesel truck emission factors (2020 fleet, 25 tons capacity).
- Diesel truck emissions are associated with the transportation of biomass to the biomass plant.

[1] Nyberg, Michael, 2009, 2008 Net System Power report, California Energy commission, CEC-200-2009-010, Table 2.

[2] Data collected through the California Energy Commission's Renewable Energy Program and Net System Power Report, and corroborated by the California Biomass Energy Alliance and industry outreach. Data do not include three MSW combustion facilities representing about 65 MW.

[3] Including generation from landfill gas, digester gas, biomass gasification and solid-fuel biomass combustion.

Table 1 Criteria Pollutant Emissions from a Solid-Fuel Biomass Plant (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
Operating Emissions[1]	0.009	0.217	0.040	0.779	0.045	0.042
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Increase in Emissions[2]	0	0.150	0.035	0.643	0.006	0.003

Sources: ARB and CEC
1. Combustion technology, excluding MSW facilities and transportation emissions
2. Increase in Emissions = Operating Emissions – 2020 Average Grid Emissions

Table 2 Diesel Truck Emission Factors (g/mi)

	ROG	CO2	CO	Sox	Nox	PM10	PM2.5
2020 Diesel Truck Fleet	0.52	2.14	3.32	0.18	7.86	0.24	0.22

Source: ARB

Agriculture Resources

- Using agriculture waste residues as a feedstock may reduce criteria pollutants resulting from an alternative method of disposal such as open burning.
- Biochar may have a positive effect on soils when used as a soil amendment. Also being assessed as a possible way to sequester GHGs in the soil.[4]

Geology and Soils

- Biochar may have a positive effect on soils when used as a soil amendment. Also being assessed as a possible way to sequester GHGs in the soil. [5]

Hazards and Hazardous Materials

- Increased truck usage may lead to higher diesel truck emissions.

[4] http://www.energy.ca.gov/2009_energypolicy/documents/2009-05-26_workshop/presentations/01_Pittiglio_Franco_CEC_Overview.pdf
[5] http://www.energy.ca.gov/2009_energypolicy/documents/2009-05-26_workshop/presentations/01_Pittiglio_Franco_CEC_Overview.pdf

Land Use and Planning

- Greenfield construction could potentially disturb large parcels of land in forested regions.
- Biomass facilities could be built on land primarily used for farming.

Noise

- Potential impact from truck traffic and power plant operation.

Population and Housing

- Potential impact from truck traffic.

Transportation/Traffic

- May increase local traffic congestion due to increased truck traffic to the facility.

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

California Air Resources Board, *CEIDARS Database*

California Air Resources Board*, Initial Statement of Reason Proposed Regulation to Implement the Low Carbon Fuel Standard, Volume I and II,* March 2009

California Energy Commission, California Electrical Energy Generation website: http://energyalmanac.ca.gov/electricity/electricity_generation.html

California Energy Commission, *Energy Almanac*

California Energy Commission, 33% by 2020 website: http://www.energy.ca.gov/33by2020/documents/

Energy Information Administration, *Biomass for Electricity Generation*, 2004

National Renewable Energy Laboratory, *Lessons Learned from Existing Biomass Power Plants*, February 2000

Potential Environmental Impacts From Landfill/Digester Gas Power Generation

BACKGROUND

- Landfill/digester gas generation represents about 0.5% of total system generation and 5% of renewable generation (in-state and imports); Produced more than 1,500 GWhs in 2008.
- 102 facilities in California generate 345 MW.

ENVIRONMENTAL IMPACTS

Air Quality

- Table 1 compares criteria pollutant emissions from a landfill gas power plant to the average generation emissions from the California electricity grid.
- Operating emissions do no include emissions from digester gas plants. ARB staff is currently evaluating emissions from digester gas plants.
- Operating emissions only include emissions from power generation.

Table 1 Criteria Pollutant Emissions from a Landfill Gas Power Plant (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
Operating Emissions	0.025	0.220	0.026	0.571	0.018	0.018
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Change in Emissions[1]	0.016	0.153	0.020	0.435	-0.021	-0.021

Sources: ARB and CEC
1. Change in Emissions = Operating Emissions – 2020 Average Grid Emissions

Agriculture Resources

- Installation of gas collection system components disturbs vegetation.
- Replanting vegetation replaces disturbed vegetation.
- High CO_2 and CH_4 concentrations and low oxygen levels are injurious to many types of vegetation.

Biological Resources

- Animal disposal and animal health are concerns associated with emerging animal diseases.
- There are no pathogens in digester gas.

Energy Demand

- Landfill gas collection systems without energy recovery devices require energy to run the blowers and pumps. Additional energy required for the gas collection and control system may not place an undue burden on the existing electrical generation.

Hazards and Hazardous Materials

- Handling of condensate from the dewatering process in landfill gas recovery facilities may expose people to hazards and hazardous materials.

Noise

- Noise from blowers used to extract gas from the site exposes people residing or working in the project to excessive noise levels.

Population and Housing

- Odor from organic materials may cause people to move away or discourage people from buying houses in the surrounding area.
- Dairy digesters reduce diary manure odor.

Solid/Hazardous Waste

- Disposal of condensate from the dewatering process in landfill gas recovery facilities may expose people to solid/hazardous waste.

Water Quality

- Gas may migrate from the landfill to contaminate groundwater. Modern landfills are equipped with liners and leachate removal systems to prevent contamination to the groundwater.

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

California Air Resources Board, *CEIDARS Database*

California Air Resources Board, *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*, May 2009

California Energy Commission, Biomass to Electricity website: http://www.energy.ca.gov/biomass/index.html

California Energy Commission, California Electrical Energy Generation website: http://energyalmanac.ca.gov/electricity/electricity_generation.html

California Energy Commission, 33% by 2020 website: http://www.energy.ca.gov/33by2020/documents/

Potential Environmental Impacts From Small Hydroelectric Power Generation

BACKGROUND

- In 2008, 158 small hydroelectric projects existed in California
- Over 1,100 MW of small hydroelectric generation capacity existed in California
- Small hydroelectric facilities are defined as hydroelectric plants that generate 30 MW or less.
- 3 small hydroelectric projects are in development.

ENVIRONMENTAL IMPACTS

Air Quality

- Small hydroelectric facilities do not emit criteria pollutants
- Table 1 compares criteria pollutant emissions from a small hydroelectric plant to the average generation emissions from the California electricity grid.

Table 1 Criteria Pollutant Emissions from a Small Hydroelectric Plant (kg/MWh)

	ROG	NOx	SOx	CO	PM10	PM2.5
2020 Average Grid Emissions	0.009	0.067	0.006	0.136	0.039	0.039
Operating Emissions	0	0	0	0	0	0
Avoided Emissions[1]	0.009	0.067	0.006	0.136	0.039	0.039

Source: ARB and CEC

1. Avoided Emissions = 2020 Average Grid Emissions - Operating Emissions

Aesthetics

- Hydroelectric turbines and associated facilities can be visible because of their size, location and materials. However, the visual impacts can be mitigated and are not the primary concern for hydroelectric facilities.

Biological Resources

- Potential impacts on fish, water borne wildlife, and surrounding flora and fauna.
- Potential impacts on marshlands and downstream habitat.
- Impacts to biologically diverse habitat and ecosystems.
- Guidelines exist to mitigate some biological impacts.
- Certification process for low-impact hydroelectric projects is in place.

Land Use and Planning

- Minimal impact to land use and planning.

Transportation/Traffic

- Access roads need to be provided for project construction and future maintenance.

Water Quality

- Stream bed alteration sometimes required.
- Stringent permitting processes through the US Army Corp of Engineers, U.S. Fish and Wildlife, and California Department of Fish and Game exist for streambed alteration and wetland impacts.
- Impacts to natural sedimentation flow.
- Impacts on water flow, and downstream physical river characteristics.

Other Impacts

- New transmission lines may be needed to connect to the transmission grid.
- Electricity generated through small hydroelectric power is very dependent on rainfall, weather patterns, season flows, and the upstream physical environment. As a result, small hydroelectric power may have reliability issues and require back up power sources.

ENVIRONMENTAL JUSTICE

- ARB staff is currently evaluating impacts to specific environmental justice communities.

REFERENCES

California Air Resources Board, *CEIDARS Database*

California Energy Commission, *Energy Almanac*

California Energy Commission, California Electrical Energy Generation website:
http://energyalmanac.ca.gov/electricity/electricity_generation.html

California Energy Commission, Consumer Energy Center website:
http://www.consumerenergycenter.org/renewables/hydro/index.html

California Energy Commission, 33% by 2020 website:
http://www.energy.ca.gov/33by2020/documents/

Low Impact Hydropower Institute
http://www.lowimpacthydro.org/